Game-Based Learning Effectiveness and Motivation Study between Competitive and Cooperative Modes

[1*]Chang-Hsin Lin, [1]Shu-Hsien Huang, [1]Ju-Ling Shih,
[1]Department of Information and Learning Technology
National University of Tainan
Tainan, Taiwan
changhsinlin1206@gmail.com,
shuhsienhuang@gmail.com,
juling@mail.nutn.edu.tw

[2]Alexandra Covaci, [2]Gheorghita Ghinea,
[2]Department of Computer Science
Brunel University
London
alexandra.covaci@brunel.ac.uk,
george.ghinea@brunel.ac.uk

Abstract— **The aim of this paper is to compare the learning effectiveness and learning motivation of digital game-based learning between the competitive and the cooperative mode. Forty-seven junior high school students were invited to participate in the learning experiment. The students were divided into two groups and played Fragrance Channel in two different modes. Pre- and post-tests were used to evaluate students' learning effectiveness under different conditions and an IMMS questionnaire was used to evaluate learning motivation. The results show no significant differences for both groups when evaluating learning effectiveness and motivation. However, both groups presented significant differences between their pre- and post-tests conditions when it comes to the acquired knowledge. We identified significant differences also for the satisfaction level showing that students enjoyed it more to play in the competitive mode.**

Keywords- game-based learning, competition, cooperation.

I. INTRODUCTION

Learning has evolved into more interactional forms and research has confirmed many times the positive effects of cooperative learning on different outcomes [1]. While teachers create a good team atmosphere to allow peer cooperation to happen, students work towards group goals and benefits together. This positive interaction can help them to create win-win situation in learning, and thereafter enhance learning effectiveness [2]. Competition is also part of our lives and is often used to stimulate learning motivations and learning performances. However, competition could lead to learning anxiety since the aggressive competitive atmosphere might cause interpersonal relationship breakdown and social adoption difficulties [1].

In general, games have great potential to support learning experiences. This engagement happens when learners are motivated. Competition and cooperation are often used in motivating students in learning activities and games. Although the comparison of the two modes has been widely discussed in the social science arena, it is still not clear which of them has more efficient effects in learning.

Therefore, we aim to investigate which mode of interaction during playing has a better potential on enhancing learning effectiveness and learning motivation. We are also interested in identifying what kinds of games are preferred by students. Our initial assumptions are that the cooperative mode of game-based learning can be more efficient in the learning process, and that the competitive mode will provide intrinsic motivation for learning. Though, neither mode is solely positive or negative.

Game-based learning is known to provide experiences beyond traditional class teaching. Moreover, its instant feedback can increase the enjoyment and make learning more interesting and challenging [3]. When learning in group or working in team, students would become an united learning body within which the members depend on each other and take individual responsibilities [4] so learners can effectively take part of the learning process. Game-based learning is also known for increasing the self-awareness of student's professional level and for bringing learners into live learning situation. Thus, through learners' active participation in the learning process, they create their own cognitive structure and schema following the same mechanism to think and solve problems in the games [5].

To illustrate how cooperation and competition benefit game-based learning, we developed Fragrance Channel, a PC game based on the history of the Age of Discovery when the European countries sailed to Asia for spices and other goods. The overall content involves sailing, colonizing, trading, and social influences. For the game used in this study, we limit the learning range within spice trade therefore called the game Fragrance Channel.

In order to know which game modes can bring better learning effectiveness and learning motivation, we created the game in both competitive and cooperative modes so the students would either compete or cooperate with each other to win the game.

II. LITERATURE REVIEW

A. Game-based learning

Games have six main features: (1) games can stimulate intrinsic motivation; (2) games focus more on the process than the results; (3) games are self-intrigued and active; (4)

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games have free choices; (5) games are positive and entertaining; and (6) games are dynamic activities [6].

Due to the fact that games are characterized by interactivity, fun, and entertainment [7, 8], when coupled with good integration of instructional design, game-based learning can create a learning environment that offers more pleasure and less pressure to learners. Past studies [9, 10, 11] have also shown that when students were immersed in such an entertaining environment, both their learning effectiveness and learning motivation were enhanced.

Computer games can thus create a simulated learning environment in which students can be involved in learning by doing. The games can present the learning content in a structured way, and can be explored by students at their own pace. Thus, the integration of learning content into the games has the potential to bring effects over and above entertainment itself [12, 13].

B. Competitive and Coorperative Learning

In social studies, competition and cooperation are two major social interaction types. In educational psychology, the two types of interactions are important learning incentives [1].

In real life, competitions are common practices of human interactions. In classrooms, teachers often use competitive strategies to stimulate students' learning motivations [1]. Competition-based learning refers to learning situations where students reach their learning goals by defeating others. There exists less interdependency between people, and learners tend to exhibit a more aggressive attitude to reach a higher status or obtain better resources. This, therefore, leads to more anxiety among students, and more learning pressure. Johnson and Johnson [14] offered strategies that require teachers to emphasize the learning process instead of the gaming outcomes, and create group competitions instead of individual competitions. Thus, in controlled situations, competition-based learning can effectively enhance learning outcomes.

Since 1970, cooperative learning has been a popular teaching strategy [11]. It requires students to cooperate with peers, and share information and efforts to reach common goals [15]. Many studies proved that students are more involved in discussions, and that the class atmosphere makes them active thinkers. Thus, students with low achievements can benefit from the guidance of students with higher achievements. However, different student backgrounds and personalities can cause cooperative learning to fail. Group discussions and decisions can be dominated by certain students, and other students would take free rides in the group assignments [14].

With the upsides and downsides of the two interaction modes, our goal in this study is to investigate the different effects of competitive and cooperative modes used in the digital.

C. Learning Motivation-ARCS

In order to evaluate students' learning motivation, a structural theory along with validated evaluation paradigm needs to be found. The Attention, Relevance, Confidence, Satisfaction (ARCS) model is a systematic teaching and learning model that Keller created from psychology and motivation theories [16], which seems to be appropriate for this study. Keller proposed that learning motivation has a strong connection with instructional design and learning effectiveness. For evaluation, the Instructional Material Motivational Survey (IMMS) was developed, which includes four aspects: Attention, Relevance, Confidence, and Satisfaction. Attention evaluates the level of learners' curiosity and interests; Relevance evaluates learners' feelings of learning content in relation to oneself; Confidence evaluates learners' attitude and their confidence on learning; lastly, Satisfaction evaluates whether learners are satisfied with their learning process and application to the future life [17]. Small and Gluck [18] also observed that the ARCS motivation model strengthens systematic instructional design ensuring that the design of materials can increase learners' participation and interaction. Motivation is what influences learners in terms of their devotions and learning durations.

ARCS is also used to evaluate students' internal learning factors and external teaching factors. It integrates cognitive and behavioral learning concepts that require learning materials to fit students' learning needs [19]. Keller and Suzuki's [20] research results show that using ARCS strategies can help improve learners' attendance rate and enhance their learning attitudes. Moreover, students' learning attitude influences their learning motivation, and thus further influences their learning effectiveness [21].

Therefore, in this paper, we aim to understand students' learning motivation while using our game and its influence on their learning effectiveness. For evaluation we use an IMMS questionnaire.

III. GAME DEVELOPMENT

The game Fragrance Channel was developed in Unity 3D. The game's architecture is depicted in Figure 1. Fragrance Channel is a multiplayer-game that connects four people in a single session via Internet. Photon Server kits were used to connect the players to the Internet Server, which allows them to interact online. In the gaming process, all Clients were connected to the database of the SQL Server to read users' gaming data. After the players successfully established a network connection, they are able to communicate through text messages using the chat room via the Client server. All text communications in the chat room and the gaming process are documented on the SQL Server.

The game uses the Age of Discovery in 17th century as its context, with learners representing different countries that conduct the trade of spices. While playing the game, the students acquire knowledge about the historical context, the characteristic spices for each location, and the trading

conditions. Fragrance Channel was designed to be played in two modes:

- **Competitive mode**: Players compete towards achieving the highest trading score.
- **Cooperative mode**: Player need to cooperate in order to achieve a preset trading score

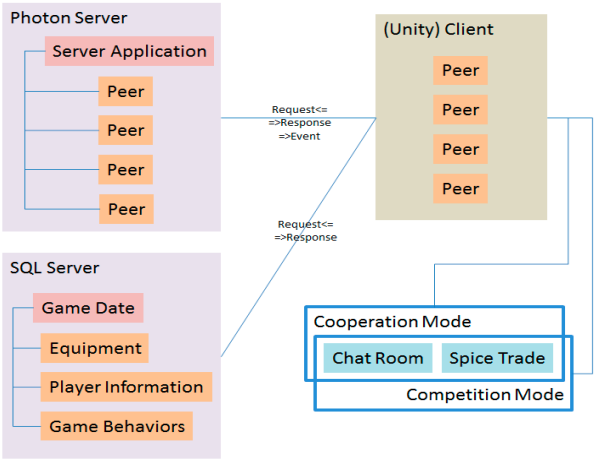

FIGURE 1. GAME SYSTEM

On the game map (Figure 2), there are 34 sailing zones which are used for calculating sailing distance. Out of the 34 zones, 13 are ports where players can retrieve supplies; however, players can only sail into the ports tagged with their national flags because those are colonies belonging to their respective countries. Six of the considered zones have different spices associated. In order to obtain the spice, the player needs to pulls into the port of its zone. The white boxes show the detailed information for the location of the six spices that need to be collected.

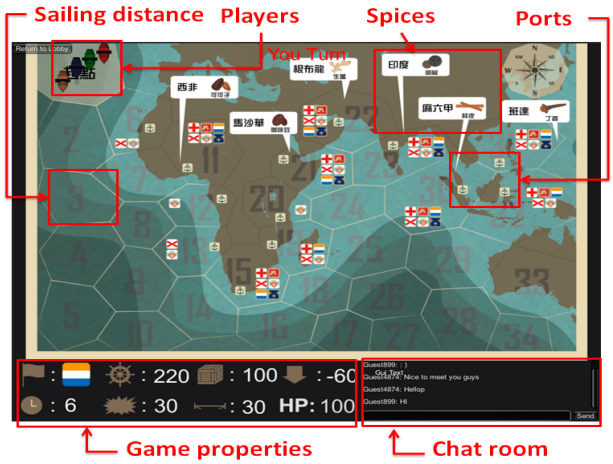

FIGURE 2. FRAGRANCE CHANNEL MAP

The game procedure is detailed in Figure 3. Each group of four players is assigned a room number. Once all four players log into the room, the game starts. Every round of Fragrance Channel runs in a time frame of 15 minutes and includes two main steps.

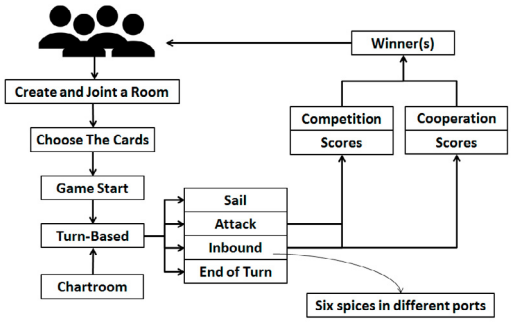

FIGURE 3. GAME PROCEDURE

Step 1 – configure ship. Here, players take turns in choosing cards to define their preferred ship parts. Thus, each player has to choose a specific Country, Hull, Oar, Sails, and Weapon. These cards are used to define the power of their ship through computations for: Propulsion Power, Cargo Capacity, Deceleration, Firing Distance, Harm, Sailing Force (Figure 4). After the four participating players configure their ships by selecting all the necessary ship parts, step 2 starts.

FIGURE 4. SAMPLE CARDS OF SHIP PARTS

Step 2 - spice trade. As we mentioned before, six zones on the map have a characteristic spice associated: Cocoa Bean, Coffee Bean, Ginger, Pepper, Cinnamon, or Clove. When step 2 starts, the players are informed through a game riddle (Figure 5, left) about which of the six spices has the highest value during that round. Players have to solve the riddle by looking for the spice information and its zone of production (Figure 5, right). After they identified the place where they can collect the spice, players sail towards that location to get the spice and ship it then home to get the points.

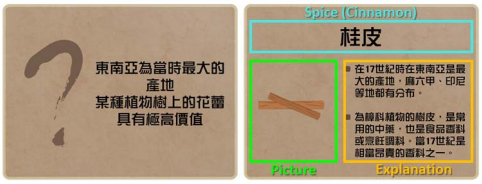

FIGURE 5. THE GAME RIDDLE (LEFT) AND LEARNING CONTENT (RIGHT)

In every round, each player can make four actions (if applicable): Sail, Attack, Inbound, and End of Turn. Every action is done by throwing dices. The points on the dice are combined by the game system with the players' ship Propulsion Power. The result is then translated into sailing distance, and on this basis, the ship sails to the designated location of the players' choice. The players take turns to play the game until the game goal is reached. If the player'

ship was attacked, the quantity of the carried spice would be reduced.

IV. RESEARCH DESIGN

The research is a quasi-experimental study. The learning target is a group of junior high school students in the southern part of Taiwan. Two classes of 47 students were chosen randomly. The experiment group (n=22) played the game in competitive mode, and the control group (n=25) played the game in cooperative mode.

Two research tools were used. Pre- and post-tests of the learning contents were used to assess students' learning effectiveness; IMMS questionnaire, based on ARCS model, was used to evaluate students' learning motivation. T-tests were conducted to see the differences.

All the students took the pre-test to make sure they have similar knowledge levels. Then, the teacher used 15 minutes to explain the mechanism of the game, and divided the students in groups of four by heterogeneous grouping. Both classes played the game for 30 minutes. After the end of the game, they took the post-test and completed the IMMS questionnaire.

V. RESULTS

An independent sample t-test was conducted to check that students have similar knowledge levels before starting to play the game. Research results show that the difference between the experimental group (M=15.8, SD=15.24) and the control group (M=11.2, SD=15.106) was t=1.036 (p>.05), which shows no significant difference between participants' spice trade knowledge before they start the game-based learning.

A. Learning effectiveness

Three junior high school social science teachers were invited to review and validate the learning effectiveness assessment. The tests have 16 questions with a total score of 100 points. Pre- and post-tests have the same questions. A paired sample t-test was conducted to see the differences.

The test results are presented in Table 1. The difference between the pre- and post-tests of the experiment group is t=8.507 (p<.001); and the control group is t=8.215 (p<.001); both groups have reached significant differences. This shows that the digital game-based learning can efficiently help students to acquire knowledge in both cooperative and competitive playing modes.

TABLE 1. PAIRED SAMPLE T-TEST OF LEARNING EFFECTIVENESS

Group	N	Pre-test		Post-test		*t*
		M	*SD*	*M*	*SD*	
Experimental	22	15.8	15.244	49.77	18.643	8.507***
Control	25	11.2	15.106	40.9	19.670	8.215***

***p<.001

In order to understand whether one game mode technique is more effective than the other, a one-way ANOVA was conducted for the post-tests. The results show no significant difference between the two groups as F(1, 45)=.121 (p>.05) (table 2).

TABLE 2. RESULTS OF ONE-WAY ANOVA OF LEARNING EFFECTIVENESS

Source	df	SS	MS	*F*
Between groups	1	921.253	921.253	.121
Within group	45	16584.864	368.553	
Total	46	17506.117		

B. Learning motivation

The IMMS Survey for learning motivation uses a 5-point Likert scale from 1 as Strongly Disagree to 5 as Strongly Agree with total of 36 questions. The Cronbach's α for both groups was above 0.8 and shows high response validity. The results of the four aspects considered (Attention, Relevance, Confidence, and Satisfaction) are shown in Table 3. In order to investigate in-depth 4 aspects, a one-way ANOVA test was conducted to examine the differences between the two groups.

TABLE 3.AVERAGE OF IMMS SURVEY

Group	A	R	C	*S*
competition	3.27	3.09	3.20	3.37
cooperation	3.06	2.91	3.01	3.00

The results for the Attention aspect are shown in table 4 as F(1, 22)=.902(p>.05), and there are no significant differences between the two groups. This shows that both gaming modes elicit similar attention levels in students and maintain their interests in the game. It also confirms results of previous research which showed that game-based learning can increase students' attention due to the increased interaction between them [22].

Moreover, we observed that in the competitive mode, players are still paying attention when it's others' turn, since other players' actions might influence their own gaming progress and strategy. When it comes to the cooperative mode, participants share their resources and scores and are absent minded when it is not their turn.

TABLE 4. RESULTS OF ONE-WAY ANOVA OF ATTENTION ASPECT

Source	df	SS	MS	*F*
Between groups	1	.043	.043	.902
Within group	22	1.037	.047	
Total	23	1.080		

The results of the Relevance aspect are shown in Table 5 as F(1, 22)=2.244(p>.05). Again, no significant differences were found showing that both gaming modes brought a similar learning relevance to the students. However, the Relevance aspect scored low relative to the other three aspects. We believe that this is because the learning content of the Age of Discovery and specifically the spice trade is not taught in the school curriculum. Learners thus feel more distant from the content and cannot link the knowledge to their personal experiences. Nevertheless, learners are still willing to learn new things since the content presentation in the game is interesting.

TABLE 5. RESULTS OF ONE-WAY ANOVA OF RELEVANCE ASPECT

Source	df	SS	MS	*F*
Between groups	1	.144	.144	2.244
Within group	16	1.026	.064	
Total	17	1.170		

The results of the Confidence aspect are shown in Table 6 as $F(1, 22)=2.554$ ($p>.05$), with no significant differences being found. It shows that students can obtain learning confidence in both gaming modes. The average of competitive mode is slightly higher than the cooperation mode. From the observations, we see that players could get a sense of achievement and confidence by successfully attacking others, or get scores by returning to their own ports. Reversely, the players of cooperative mode do not get instant feedback since they can only achieve their goals when all four players reach the goal.

TABLE 6. RESULTS OF ONE-WAY ANOVA OF CONFIDENCE ASPECT

Source	df	SS	MS	*F*
Between groups	1	.165	.165	2.554
Within group	16	1.033	.065	
Total	17	1.198		

The results of the Satisfaction aspect are shown in Table 7 as $F(1, 10)=13.302$ ($p<.05$), with significant differences being found between the two cohorts. It shows that students favor the competitive mode of the digital game, Fragrance Channel, over the cooperative mode. Students in the competitive mode gave more positive feedback such as asking whether they can play it again, or whether they can download the app. In cooperative mode, however, since some players rely on others for the group's achievements, this lowers their partners' satisfaction rate.

TABLE 7. RESULTS OF ONE-WAY ANOVA OF SATISFACTION ASPECT

Source	Df	SS	MS	*F*
Between groups	1	.418	.418	13.302*
Within group	10	.314	.031	
Total	11	.732		

VI. CONCLUSION

As resulted from the research reported in this paper, the two gaming modes, competitive and cooperative, do not bring significant differences in the learning effectiveness and learning motivation. Although the pre- and post-tests have significant improvements, the total post-test score were still not satisfactory. This might be due to the limited gaming time that learners had to experience the game. For future research, a longer gaming time might be necessary.

Moreover, both groups show an evident increase in their learning motivation. The competitive playing mode can bring about more satisfaction due to the instant feedback the game provides. Competition seems to work better than cooperation.

From our observations, many interesting interactions happened during the game, and different strategies were used while the students were involved in different gaming modes. Future research will analyze learners' interactions. Moreover, the strategies that learners use in relation to their personalities might also be worthwhile exploring. This will help us and the community gain new insights into the effects of different gaming modes on learners.

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